Space Weather Technical Forecast

Issued on Sunday 3 November 2024 at 13:06 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Moderate to High solar activity with M-flares expected, and a slight chance of X-class flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity was moderate with two M-flares, the largest of which was a M1.1 peaking at 03/0849 UTC from AR3878 in the north centre disc. There are fourteen active sunspot regions on the visible disc, with one as yet un-numbered new region. AR3878 and the cluster of spots in the SW remain the most active flare source regions. AR3878 still has two delta spots visible within its larger trailer portion, although one of these appears to be weakening. AR3869 remains the most complex region within the cluster of spots in the southwest. AR3881 in the SE continues to develop with quite large leading and trailing spots. Spot regions in the far east are rotating more clearly into view, showing some complexity to their structure. Other sunspots only showing slow evolution currently.

No Earth-directed CMEs were observed in available imagery.

Solar Wind / Geomagnetic Activity: Solar winds as measured at L1 by ACE/DSCOVR were generally at slightly elevated levels, reaching a brief peak of 511km/s, but have mostly remained around 430-450km/s. Density was below average throughout. The Interplanetary Magnetic Field (IMF), Bt, was mostly moderate, ranging between 8-11nT. The north-south component, Bz, varied weakly initially, becoming persistently positive (northward directed) from 02/2300UTC, ranging through the whole period between -8nT and +11nT. Phi angle was predominantly negative (towards the Sun) until around 03/0600UTC, when it varied between negative and positive (away from the Sun). Geomagnetic activity was Quiet to Unsettled (Kp1-3).

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 was elevated but remained below S1 Minor Radiation Storm level throughout, showing a gradual decline. High energy electron flux (greater than 2MeV) observed by GOES16 was at Background. The associated 24-hour fluence was well below the Active threshold, with 2.72e6 integrated flux observed at 03/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate or High activity is expected to continue into the start of the period, with occasional M-class flares expected and a slight chance of isolated X-class flares. Into days 2-3 (04-

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05 Nov) flare risk perhaps reducing somewhat as active regions in the west begin to rotate off the visible disk.

Solar Wind / Geomagnetic Activity: A CME which left the sun during the 31st Nov has the potential to give a glancing blow to Earth late on day 1 (03 Nov) or into early day 2 (04 Nov). Coronal holes CH86/87 may also cause some enhancement during this same period. Quiet to Unsettled geomagnetic activity is expected initially. Activity expected to increase to become more generally Unsettled later on day 1 (03 Nov) and day 2 (04 Nov), with a chance of Active and a slight chance of G1/Minor Geomagnetic Storm intervals given the risk of the glancing CME blow and HSS influence. Activity currently expected to be generally Quiet to Unsettled once again by day 4 (06 Nov).

Energetic Particles / Solar Radiation: The high energy proton flux at GOES-18 is now below the S1 Moderate Radiation Storm level, and continuing to slowly decline. However, any further notable flares bring a persistent chance for further enhancement during the period. The high energy electron flux is expected to be Background to Moderate, with the associated fluence forecast to persist below Active levels.

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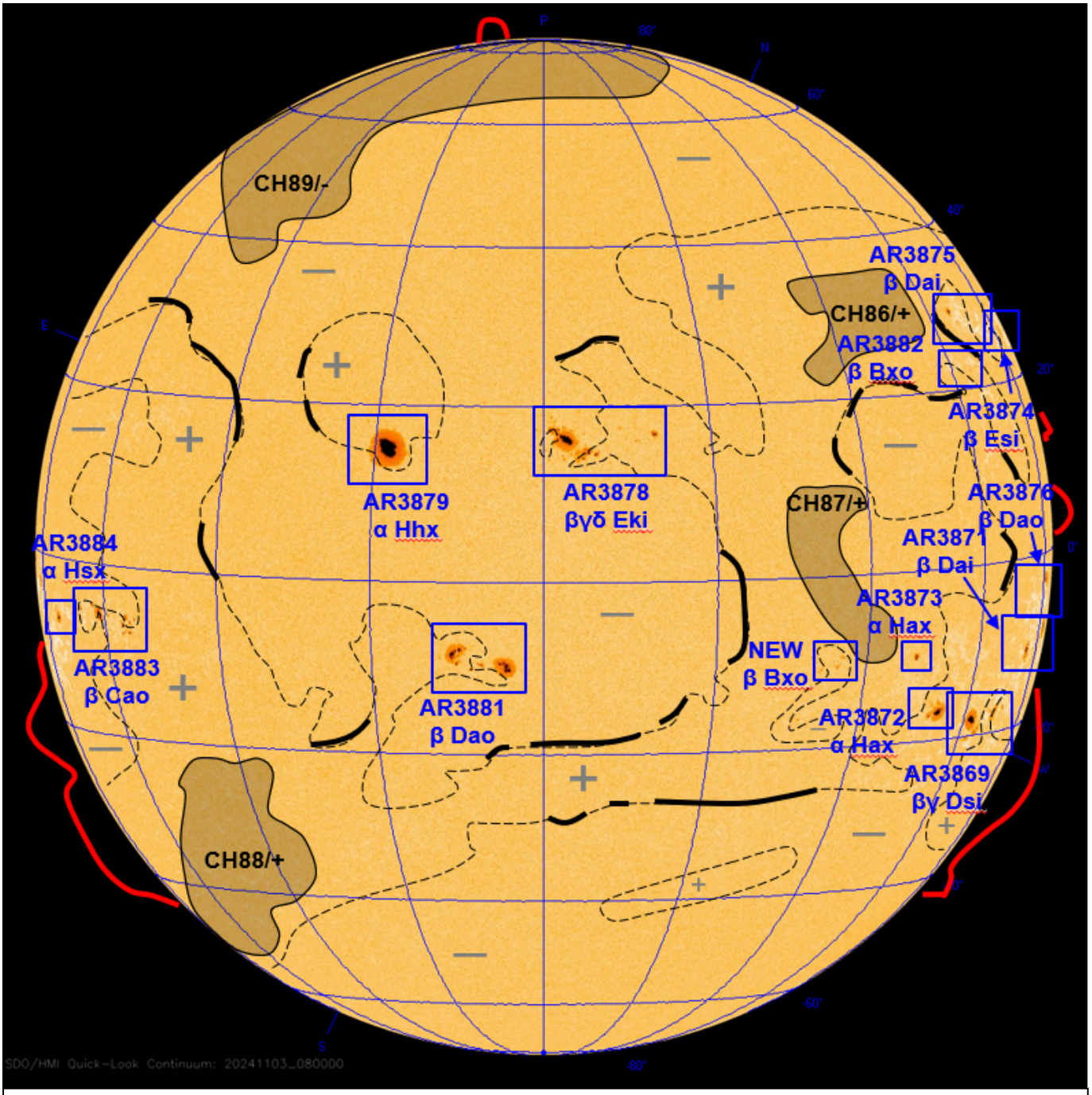
Figure 1: Solar Synoptic Map valid 03/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

A CME which left the Sun during the 31st Oct has the potential to give a glancing blow to Earth late on day 1 (03 Nov) or into early day 2 (04 Nov). This is low confidence however given a lack of imagery for analysis. These recent gaps in available coronagraph imagery, combined with the number of large filaments on the Earth-facing disc and the continued chance for notable flares, results in a CME forecast which has a greater than usual potential to change at short notice in the coming days.

The near Earth environment continues to be weakly enhanced with winds currently at slightly elevated levels. Coronal hole CH86/+, or more likely CH87/+ to its south, may cause further enhancement of the solar winds, perhaps to elevated levels, through the latter part of day 1 (02 Nov) or into day 2 (04 Nov) . While these features are recurrent ones, both appear larger and more prominent on this rotation, which suggests that the current solar wind increase might be underestimated by the MOSWOC ENLIL model.

Quiet to Unsettled geomagnetic activity is expected initially. Activity expected to increase to become more generally Unsettled later on day 1 (03 Nov) and into day 2 (04 Nov), with a chance of Active and a slight chance of G1/Minor Geomagnetic Storm intervals given the combined risk of a glancing CME blow and HSS influence. Activity currently expected to be generally Quiet to Unsettled once again by day 4 (06 Nov) although forecast lower than usual confidence.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	20	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
31/1915	Partial	AR3877	central-southern disk	600	04/0300 +-6hr	Low confidence, glancing blow.

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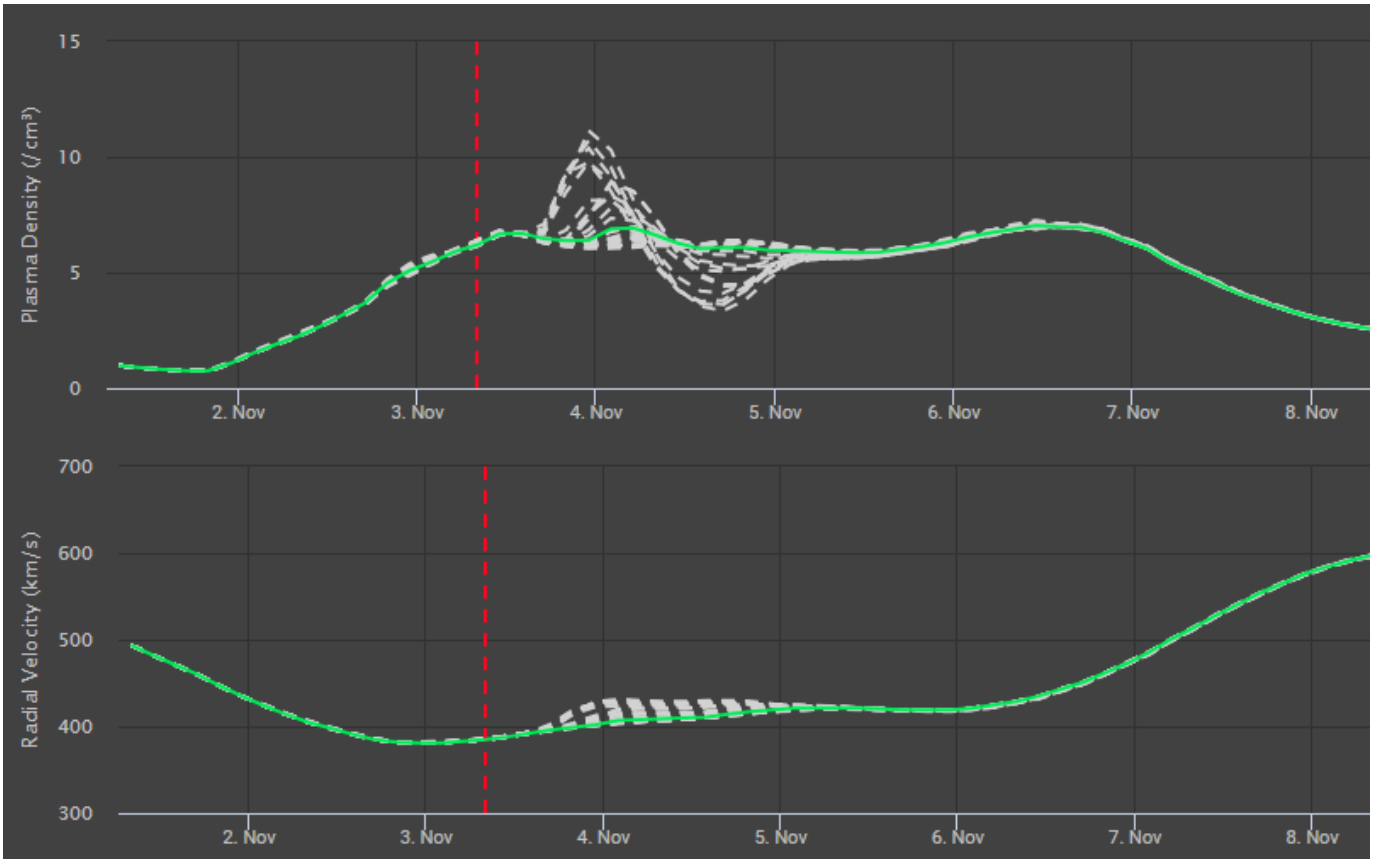
Figure 2: MOSWOC Ensemble model showing possible CME glance. Note that coronal hole influence towards end of the period is likely too late.



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Radio Blackouts - X-Ray Flares

There are fourteen active sunspot regions on the visible disc, with one as yet un-numbered new region. AR3878 in the north-centre disc, and the cluster of spots in the SW, remain the most active flare source regions. AR3878 still has two delta spots visible within its larger trailer portion, although the southernmost one does appear to have weakened significantly. AR3869 remains the most complex region within the cluster of spots in the southwest, with opposite polarity to what would be expected for a southern disc sunspot ("anti-Hale"), although these regions are becoming harder to assess accurately as they approach the western limb. AR3881 in the SE continues to develop with quite large leading and trailing spots. Two newly numbered regions near to the eastern limb are beginning to reveal some complexity to their structure, and are likely to see their classifications change over the coming days as they come more into view. Other sunspots only showing slow evolution currently.

Moderate or High activity is expected to continue initially, with occasional M-class flares expected and a slight chance of isolated X-class flares. By day 2 (04 Nov) and into day 3 (05 Nov) regions leaving the western limb may see a slight decrease in the total flare risk, with recurrence and far-side sounding imagery not suggesting any significant oncoming regions. Therefore the flare risk reducing slightly into the period, although Moderate activity remains likely pending further developments.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 (M Class)**	Yes	80	70	70	70
Very Active	**R3-R5 (X Class)**	No	20	20	15	15

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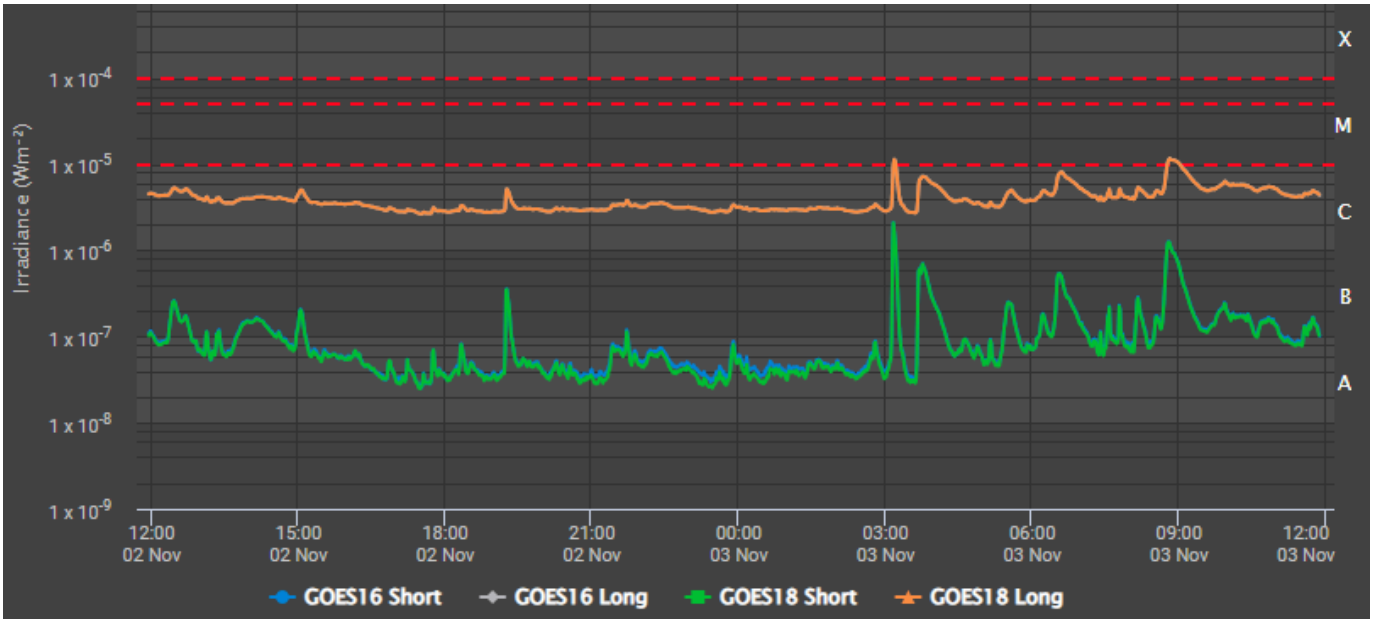
Figure 3: GOES-16 & -18 X-ray flux over past 24hrs



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Solar Radiation Storms (High Energy Protons)

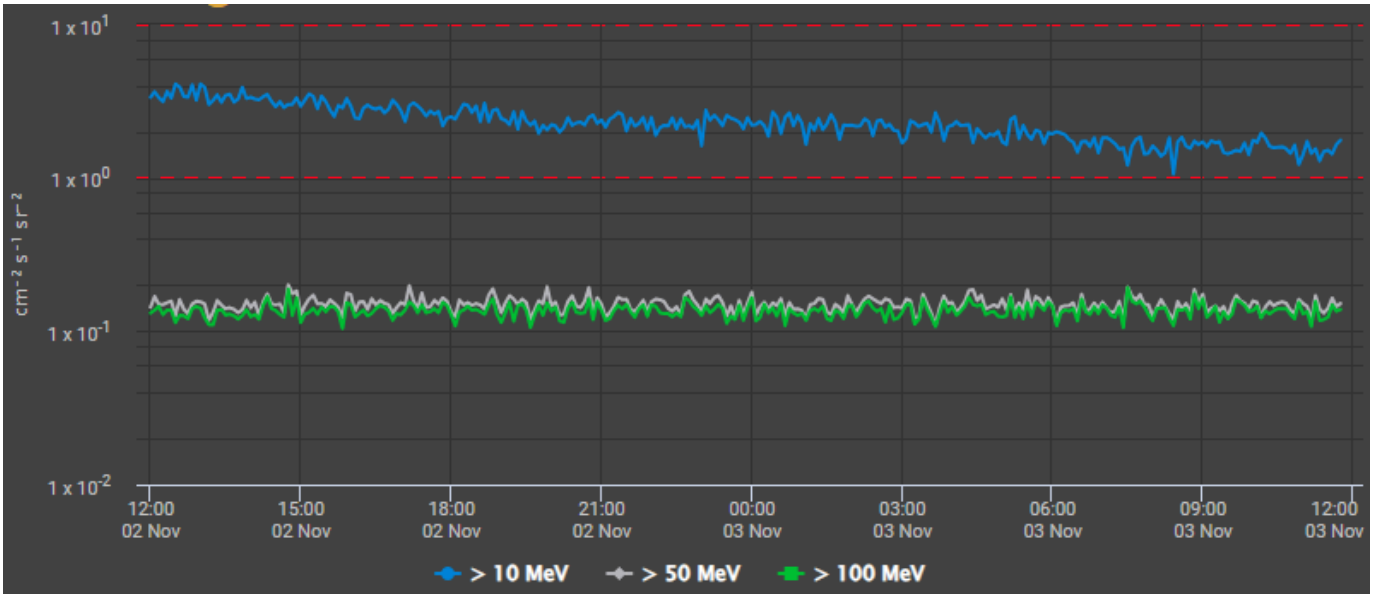
The recently elevated high energy proton flux at GOES-18 over previous days has now fallen below the S1 Minor Radiation storm level and is expected to decline towards background through days 1 and 2 (03-04 Nov) in the absence of any further enhancement.

Further enhancements remain possible however, with the potential for notable flares from a number of the sunspots on the disc. This includes the cluster of regions in the western disc, all of which will remain in potentially geo-effective positions through the period even as some spots round the western limb. The proton risk associated with AR3878 will also only increase into the period as this region transits west, although only limited proton response has been diagnosed from the recent significant flares from this region.

Overall there is a persistent chance of further proton enhancement though the period, reducing slightly through the latter half as conditions likely continue to ease in the absence of further enhancement.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	25	25	20	20
Very Active	**≥ S3 ***	No	5	5	5	5
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES-18 Proton flux over past 24hrs



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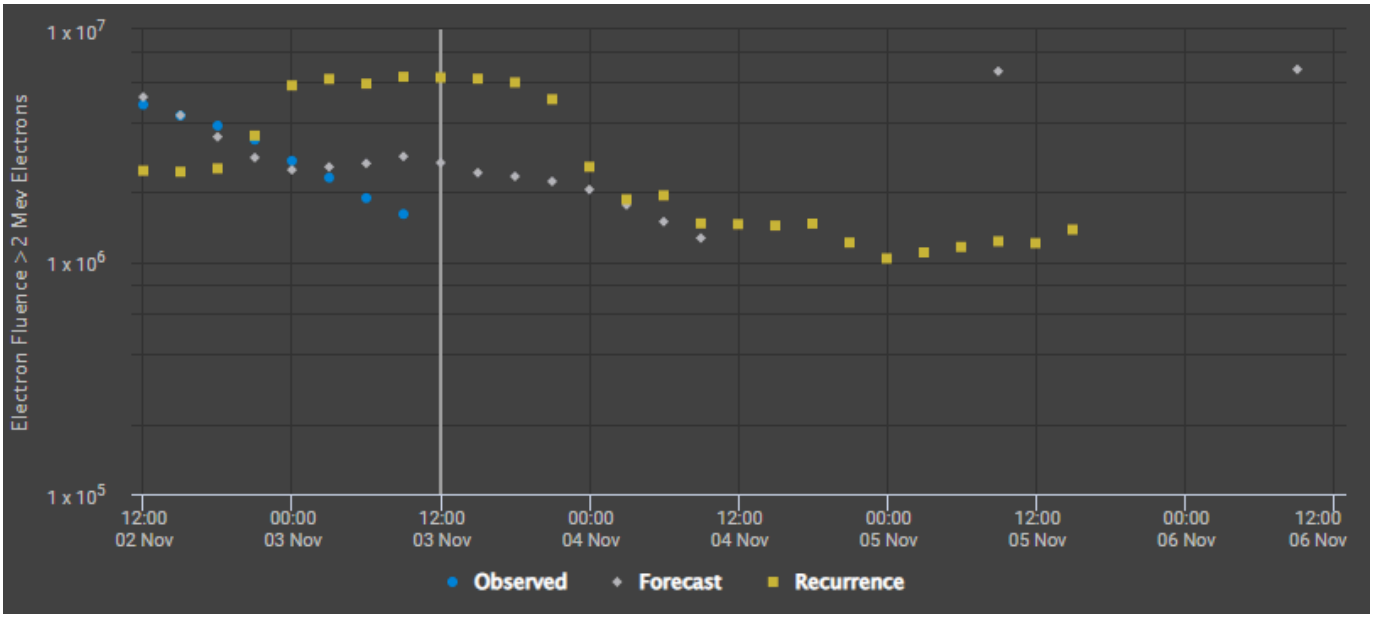
High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2MeV) as observed by GOES16 is currently at background and expected to persist mostly at this level, with only brief spells of moderate enhancement expected.

The associated 24-hour fluence is currently expected to remain well below Active throughout the period, with the MOSWOC REFM forecast though to be providing reasonable guidance.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	1
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 5: MOSWOC REFM



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